No. 136 September 2007

solplan review

the independent journal of energy conservation, building science & construction practice

Inside . . .

Heating Equipment 3
Heating System Alphabet Soup 4
Integrated Space/Water Heating Systems 7
Heating System Efficiency: Points to Consider.....8
Spray Foam Insulation 9
Letter to the Editor.....11
Spray Foam Insulation Must Be Installed Properly .. 11
Indoor Air Quality.....12
Energy Standards for Houses.....13
Environment and Global Warming are Top Issues for Canadians 14
Technical Research Committee News.....15
Field Investigation On The Use Of ACQ Treated Wood And Metal Fasteners And Connectors
Energy Answers 16
Solar Energy Applications 17
IRC Software for Building Designers.....18
Fire Research for Better Building Design: NRC-IRC Building Science Insight Seminar.....19

Heating Equipment

From the Editor . . .

There are times I have concerns about the message that some in our industry are sending the public. We insist that we build good quality product, and in general that is the case. But when codes and standards are adjusted to raise the bottom, to create a higher level playing field, to ensure everyone builds to a better minimum standard, things change.

In recent years we've learned the importance of proper design and detailing of building exterior finishes in order to properly manage water. The "leaky condo" crisis in BC led to a review and rethinking of how we detail exterior claddings. We learned that we've become sloppy in our standard practices with the result, in far too many cases, of catastrophic building envelope failures, and the problem is not unique to the BC coast.

It has also led to changes in the building code, clarifying that the exterior cladding must incorporate two planes of protection. In extreme exposure conditions, the exterior must incorporate a capillary break, also known as a rain screen, which must be a cavity at least 10 mm. We have known about rain screen details for a long time, yet failed to apply them until forced to by circumstances and eventually by regulation.

Yet we still see some West Coast builders, in particular on Vancouver Island, fighting the building code changes, claiming that they are unnecessary. The argument made is that single-family dwellings don't need a rain screen – they question whether a problem even exists. The refrain is "where is the evidence showing that there is a problem? How many building envelope failure claims have the home warranty companies seen?"

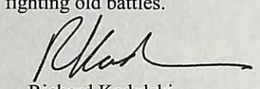
What they ignore or don't care to acknowledge is that a single-family home owner is not as likely to discover a problem until a number of years have passed – the construction may be sufficiently robust that a significant amount of moisture accumulation will take place, and it will take some time to elapse before the failure manifests itself by which time warranty claim periods have passed. And in the case of a single family dwelling, the homeowner has to deal with the remedial actions on his own, assuming he discovers the problem in time before it gets too bad. There is no mechanism such as in a multifamily condominium where a number of owners are forced to deal with a problem that cumulatively has a large dollar value. In the multifamily situation, the problem is shared among a number of individuals who can band together and cry on each other's shoulder.

Contrary to perceptions, there are building envelope problems in single-family houses. I have seen numerous examples. And when I talk with renovators, they acknowledge they have seen plenty of evidence of moisture problems. It's just that in the case of individual homes, the problem has a low profile and is below the public radar.

One argument used to fight code changes is that rain screen construction adds costs to construction, and so will affect affordability in an already expensive region. However, affordability is not affected by technical issues as much as by design features. We may have been part of the problem by creating raised expectations for housing. Those extra features we so often feature – be it the granite countertops, the extra bathrooms, the extra square footage, or other features we see in today's homes compared to even ten or twenty years ago – have a bigger impact on costs. And repair of envelope problems after the problems have been discovered can be a bigger burden on the homeowner than doing it properly at the outset.

Another argument raised is that requiring rain screen cladding creates a problem because there are not enough trained siding applicators. However, that is a different problem, perhaps an admission of failure on our part in not coming to terms with adequate training.

If we really mean to build better housing, we've got to recognize that it may take more effort than we've become accustomed to in recent years. We need to get on with the appropriate details behind the finishes, and not spend the effort fighting old battles.



Richard Kadulski,
Editor

solplan review
the independent journal of energy conservation, building science & construction practice

Editor-Publisher: Richard Kadulski
Illustrations: Terry Lyster
Contributors: John Ruddick, John Burrows, Rob Dumont, Jim Gallagher, Janet Ansell
ISSN: 0828-6574
Date of Issue: October 2007
SOLPLAN REVIEW is published 6 times per year by:
the drawing-room graphic services ltd.
PO Box 86627, North Vancouver, BC V7L 4L2
Tel: 604-689-1841 Fax: 604-689-1841
e-mail: solplan@shaw.ca
Street address:
#204 - 1037 West Broadway
Vancouver, BC V6H 1E3
Publications Mail Agreement No. 40013363

Postage paid in Vancouver, BC.
Return undeliverable Canadian addresses to
PO Box 86627, North Vancouver, BC V7L 4L2
COPYRIGHT 2007 by The Drawing-Room Graphic Services Ltd. All rights reserved.
Reproduction without written permission of the publisher is strictly forbidden. Transgressors who don't take heed note: that white stuff you see on your jobsite won't be just hoar frost.
A license for photocopying or other reprographic copying can be also be obtained from Access Copyright (Canadian Copyright Licensing Agency, 1 Yonge St., Suite 800, Toronto, ON M5E 1E5).
SUBSCRIPTIONS: In Canada 1 year $51.94 (incl GST) (NB, NS, NF $55.86 includes HST); 2 years $93.28 (incl GST) (NB, NS, NF $100.32 includes HST). USA and other foreign payable in US $ 1 year $56.00, 2 years $102.00.

CHANGE OF ADDRESS: include a mailing label or copy all information off label for faster, accurate processing.
CONTRIBUTIONS: Unsolicited contributions and manuscripts welcome. Include self-addressed pre-stamped mailer if return requested. Publisher not responsible for loss or damage of same.
While every effort is made to provide accurate and complete information, we do not warrant or guarantee the accuracy and completeness of such information.
ADVERTISING POLICY: Publisher's discretion in the acceptance of any advertisement. No endorsement is stated or implied by the publisher.
PRINTED IN CANADA
GST Registration: R105208805
SOLPLAN is a registered trademark of the Drawing-Room Graphic Services Ltd.

Heating Equipment

Heating and cooling accounts for nearly half the annual energy use in a house. Because heating and cooling equipment lasts more than 10 years, the choice made when a system is being installed or replaced will affect utility bills for years. Using energy more efficiently not only means lower utility bills for the homeowner but also helps conserve non-renewable natural resources and will also produce fewer emissions that contribute to climate change.

We are getting close to building homes that require no additional heat – these are also referred to as Net Zero Energy Houses. Net Zero Energy Houses (or Equilibrium as CMHC has labeled their latest initiative), are generally considered to be homes that are energy neutral because, on an annual basis, they will produce as much energy as they consume. At northern latitudes, because of variable daylight and solar energy availability, and long cold winters, it could be a challenge unless consideration is given to energy storage.

The first Equilibrium demonstration homes currently under construction will show some real world examples in a Canadian context.

However, even the most energy efficient homes may need supplementary conditioning at some times of the year – what is important is to reduce the amount of supplemental energy required and to do it as efficiently as possible. This is all becoming easier to do as new equipment is coming on the market – pushing the technical limits – and new labeling standards are making it easier to identify appropriate equipment.

In Canada we've had Energuide ratings for some time. These labels simply show the energy performance under assumed conditions, making possible comparison between similar equipment and appliances. More recently, with the internationalization of the Energy Star label as a symbol of high energy-efficiency, NRCan has been managing the Energy Star labels on products sold in Canada. Thus, the criteria to meet Energy Star in Canada may differ from that in the US.

The Natural Resources Canada web site now lists heating and cooling equipment, including efficiency ratings and whether or not it meets Canadian Energy Star standards. We're presenting a representative selection of the most energy efficient equipment of each type currently on the market.

Geothermal Heating Systems

Geothermal heating systems, also known as ground source (or earth-energy) heat pumps, may be a recent innovation. These systems have also captured the imagination of many for their high system efficiencies and apparent "green" factor. These heat pumps take heat from the ground or surface or ground water. Because the temperature of the source of heat is relatively warm and constant year-round (recharged by the sun), the efficiency of ground source heat pumps is high.

Although geothermal systems currently account for less than 1% of all heating and cooling systems in Canada, the geothermal market is growing rapidly (44% annually in both 2005 and 2006). According to the Canadian GeoExchange Coalition, more than 40,000 geothermal heat pumps are installed annually for residential, commercial and industrial purposes.

Energy Star qualified ground-source heat pumps must meet or exceed a minimum COP of 3.3 and EER of 14.1 for closed loop systems, COP of 3.6 and EER of 16.2 for open loop systems, and COP of 3.5 and EER of 15 for direct expansion systems.

Air Source Heat Pumps

Air source heat pumps take heat from the outdoor air and move that heat to the inside for space heating. In summer, the process is reversed and the heat pump cools the living space. In Canada, a backup source of heating is normally required for cold weather operation.

Energy Star qualified air-source heat pumps are about 6% more efficient for heating and about 8% more efficient for cooling than standard models. The Canadian Energy Start criteria are equivalent to that of Region V in the US.

To qualify for Canadian Energy Star a split system must have a minimum HSPF of 7.1 and a SEER of 14, and EER of 11.5. A single package air source heat pump must have a minimum HSPF of 7.0 and a SEER of 14, and EER of 11. These criteria will be increasing January 1, 2009, for split systems to a SEER of 14.5 and EER of 12.0.

Heating System Alphabet Soup

AFUE (Annual Fuel Utilization Efficiency): A measure of the amount of fuel converted to space heat in proportion to the amount of fuel entering a gas furnace or boiler. This is expressed as a percentage.

COPh (Coefficient of Performance - heating): a measure of heating efficiency of a ground source heat pump.

COPc (Coefficient of Performance - cooling): a measure of the cooling efficiency of a ground source heat pump.

EF (Energy factors): a measure of the efficiency of a water heater.

EER (Energy Efficiency Ratio): A measure of the steady-state cooling efficiency of a heat pump. It is determined by dividing the cooling capacity of the heat pump in Btu/h by the electrical energy input in watts at a specific temperature. The higher the EER, the more efficient the unit.

HSPF (Heating Season Performance Factor): A measure of the total heat output in Btu of a heat pump over the entire heating season divided by the total energy in watt hours it uses during that time. This number is similar to the seasonal efficiency of a fuel-fired heating system and includes energy for supplementary heating.

SEER (Seasonal Energy Efficiency Ratio): A measure of the cooling efficiency of the heat pump over the cooling season. It is determined by dividing the total cooling provided over the cooling season in Btu by the total energy used by the heat pump during that time in watt-hours. The SEER is based on a climate with an average summer temperature of 28°C.

SEUE (Seasonal Energy Utilization Efficiency): A measure of energy efficiency for an oil-fired furnace, over a heating season. The SEUE is expressed as a percentage. For furnaces with no standing pilot light, the SEUE is equivalent to the Annual Fuel Utilization Efficiency (AFUE).

Geothermal Heat Pumps

Brand	Heating capacity Btu/h	Coefficient of Performance (heating) COP_h	Cooling capacity Btu/h	Coefficient of Performance (cooling) COP_c
Géoconfort	19,800	5	28,600	5.4
	37,600	4.1	51,300	5.4
Nordic	20,900	4.3	28,900	5.5
	48,000	3.85	59,900	4.4
Boreal	20,900	4.3	28,900	5.55
	39,700	3.75	51,800	5.1
Géosmart Québec	24,000	4.2	35,000	6.4
	37,600	4.1	51,300	5.4
Géonergy	25,700	4.2	39,900	5.8
	37,600	4.1	51,300	5.4
Climate Master	25,800	4.2	34,600	5.92
	30,400	4	40,000	5.86
Carrier	25,800	4.2	34,600	5.92
WaterFurnace ES Series	20,800	4	30,800	5.62
WaterFurnace ES Series	41,200	4	62,400	5.39
WaterFurnace E Series	41,800	3.9	60,000	4.98
HydroHeat	57,900	4	65,700	5.04
	38,500	3.4	30,500	4.39
Envirosaver	28,500	4	36,000	6
	49,000	3.6	62,000	4.6
Econar Vara 2 Plus	30,500	3.9	38,000	4.69
Paradise	29,000	3.8	40,000	5.59
	41,200	4	62,400	5.39

There is a wide range of equipment available. This listing shows the efficiency ratings for small units that meet the Canadian Energy Star standard. This is meant to show a representative cross section of equipment on the market. A full list of equipment on the market, including size and model number, is available on the NRCan Office of Energy Efficiency website: *www.oee.nrcan.gc.ca.*

Energy Star Gas Furnaces

Brand	Capacity (Btu/h)	Annual Fuel Utilisation Efficiency (AFUE) %
Amana	44,300	96
Carrier	38,000	96.6
Bryant	38,000	96.9
York	37,000	94
Napoleon	57,000	95
Haier	57,000	95
Goodman	43,700	95
Airco	57,000	95
Olsen	57,000	95
UltraComfort	57,000	95
Lennox	39,000	94.1
Armstrong	38,000	94.5
Luxaire	37,000	94
Coleman	38,000	94
Trane	74,000	92.5
Maytag	55,260	92.1
Tappan	55,260	92.1
Frigidaire	55,260	92.1
Westinghouse	55,260	92.1
Ducane	47,000	92.1
Keeprite	46,000	92.1
Ruud	57,000	91.4
Rheem	57,000	91.4
Broan	54,000	90.1
Smallest, highest efficiency unit		
All units have high efficiency motors		

Energy Star Oil Furnaces

High Efficiency Motor	Brand	Heating Capacity Btu/h	Seasonal Energy Utilization Efficiency (SEUE) %
No	Adams	48,000	96
No	Domback	48,000	96
No	Spartan	48,000	96
Yes	Kerr Compact	70,458	85.3
No	Airco	59,000	85
No	Olsen	59,000	85
No	ICP	73,000	84.8
Yes	Tempstar	59,200	84
Yes	Keeprite	59,200	84.3
Yes	Arcoaire	59,200	84.3
Yes	Heil	59,200	84.3
No	Clare	73,000	84.8
No	Newmac	77,000	84.8
Yes	Dettson	57,000	84.4
Yes	Heil	57,000	84.4
Yes	Bryant	57,000	84.4
yes	Carrier	57,000	84.4
Yes	Comfortmaker	59,200	84
Yes	Lincoln	59,200	84

An energy efficient house should have a small heat load. For best efficiency and optimum performance, properly sized equipment should be used. This listing shows the efficiency ratings for the smallest gas and oil furnaces that meet the Canadian Energy Star standard. This is meant to show a representative cross section of equipment on the market. A full list of equipment on the market, including size and model number, is available on the NRCan Office of Energy Efficiency website: *www.oee.nrcan.gc.ca.*

Boilers

A residential boiler is defined as a self-contained appliance with an energy input of less than 300,000 Btu per hour for supplying low-pressure steam or hot water for space heating or domestic hot water. To qualify for Energy Star, a gas- or oil-fired boiler must have an AFUE of at least 85%. Test Standards for boilers are CGA P.2-1991 (for gas-fired boilers) CAN/CSA-B212-M93 (for oil-fired boilers).

Boilers designed for space heating can also provide domestic hot water for residential applications. There are two basic methods used – indirect storage and a tankless coil.

Indirect storage. These well-insulated tanks operate as a separate heating zone with substantially reduced heat losses and higher efficiencies as compared to tankless coils.

Tankless coil. Operating a boiler with a tankless coil will reduce the overall energy efficiency of the boiler.

Gas or Propane Furnaces

Residential gas furnaces must have an AFUE rating of at least 90% to qualify for Energy Star.

The energy consumption of the blower fan is not considered in the rating. Increasingly, high-efficiency furnaces now have a variable-speed direct current (DC) motor to run the air circulation fan, which can significantly reduce electricity consumption while providing better heat distribution.

Natural Gas Boilers			
Condensing	Manufacturer	Heating Capacity (Btu/h)	Annual Fuel Utilization Efficiency (AFUE) %
Yes	Buderus	75,000	95.4
Yes	Burnham Hydronics	63,000	95.4
Yes	Viessman	81,000	95.4
Yes	Hamilton EVO duo	129,485	93.7
Yes	ProPak	129,485	93.1
Yes	Burnham Hydronics	135,000	93.1
Yes	Weil-McLain	72,000	93
Yes	Lochinvar	73,000	93
Yes	NY Thermal	92,700	92.7
Yes	IBC Technologies	138,800	92.6
Yes	Laars	112,601	92.5
Yes	Baxi	112,601	92.5
Yes	Prestige	98,100	92.2
Yes	Munchkin	46,000	92
Yes	Hydrotherm	135,000	90.6
Yes	Olsen	45,000	90
Yes	Lennox	45,000	90
No	Conematic	46,748	90
Yes	Carrier	45,000	90
Yes	Slant/Fin	43,000	87.3
No	Kerr Heritage	107,500	86.8
No	Smith	91,000	86.3
No	Mini-Star	30,100	86
No	Kiturami	65,600	85.5
No	De Dietrich	86,000	85
No	Fleetline Aquamatic	59,500	85

This listing shows the efficiency ratings for the smallest boilers from each manufacturer that meets the Canadian Energy Star standard. This is meant to show a representative cross section of equipment on the market and highest efficiencies achievable. A full list of equipment on the market, including size and model number, is available on the NRCan Office of Energy Efficiency website: *www.oee.nrcan.gc.ca.*

Oil Fired Furnaces

Residential oil furnaces must have an annual fuel utilization efficiency (AFUE/SEUE) rating of at least 83% to qualify for Energy Star. On October 1, 2008 this will increase to 85%.

Water Heaters

Storage tank water heaters are the most common type installed in Canadian homes. As the name implies, these systems heat and store hot water in a tank and there is a quantity of hot water stored and available. The efficiency of gas, propane and oil-fired water heaters is measured by a ratio called the Energy Factor. After selecting the size required, choose high Energy Factor models, as these are the most efficient.

Tankless Water Heaters

Also known as demand or instantaneous water heaters, these systems do not have a storage tank. They heat water only when it is needed, which avoids standby heat loss through tank walls and water pipes. The most basic units consist of a gas burner or electric heating element surrounded by flowing water.

Tankless water heaters are usually installed near the "point-of-use" to serve a specific need, such as under a kitchen sink. Depending on overall water usage, they may not have the capacity to supply an entire home with hot water. For this reason, they may be used as booster heaters to supplement another water heating system.

A relatively new tankless technology - the low mass water heater - is capable of supplying much more hot water to the home. These systems are typically gas-fired with electronic ignition and power exhaust, which means they are also more efficient than conventional tankless heaters. They can be connected to an external storage tank if necessary.

Anyone who has traveled in Europe or Asia will have seen these units in homes and in some guesthouses and smaller hotels, where these types of water heaters have been common for years.

Gas Water Heater Energy Efficiency Ratings			
	Brand	Input Rating (Btu/r)	Energy Factor
Storage tank type water heaters	Maytag	40,000	0.67
	State	40,000	0.65
	Lochinvar	60,000	0.62
	White	54,000	0.62
	Jetglass	54,000	0.62
	Rheem Power Vent	36,000	0.59
	Rheem Direct Vent	40,000	0.58
	Rudd Power Vent	40,000	0.64
	John Wood	40,000	0.58
Direct Vent Tankless	Rheem	20-145,000	0.82
	Rinnai	20-145,000	0.82
	Bosch	35-175,000	0.80

Energy factor characterizes the overall efficiency under average conditions, and takes into account heat loss through the walls of the tank, the flue and in combustion.

Integrated heating and domestic hot water system supplied by wall-hung boiler.

Elegant floor register, made from the same wood as finished floor. Design integrates with the flooring, but the free area available for airflow does not appear to have been calculated, so actual airflow will be substantially less than for which the system may have been designed. This may result in less heat to room than may be necessary.

Integrated Space/Water Heating Systems

Integrated space/water heating systems, also referred to as combo systems, combine the household heating requirement with the domestic hot water needs, potentially saving money on total system installation. A single water heater is used requiring only one appliance, so there is only one combustion appliance and one vent. Often these systems employ an insulated external storage tank with a high efficiency low mass boiler to first heat the water. Then the system passes hot water through a fan coil to distribute the heat around the house in a warm air distribution system, similar to a conventional furnace, or through a heat exchanger into a low temperature floor radiant heating system. In the spring, summer and fall when no heating is required, the same heater provides domestic hot water.

Although most water heaters can be used in a combination system, none at present are certified for use as space heating only appliances. In any case, for integrated systems that do not use high efficiency boilers, the initial cost saving of using a standard water heater is soon eliminated by the low seasonal efficiency of the equipment.

Virtually all standard, gas fired water heaters have a recovery efficiency of 80%, although the energy factor, which is a more accurate efficiency rating, is much less – typically in the range of 0.55 to 0.58. Because tankless water heaters don't have the losses associated with tanks, their energy factors are normally much higher. Conventional electric tank water heaters have an energy factor of about 0.87 compared with 0.91 for a high efficiency tank.

Proper system design and sizing is important. The heater must be sized to provide enough heat to warm a house on the coldest winter day, as well as hot water for domestic needs. Today most gas fired tankless systems have modulating controls that increase or decrease energy input to maintain the selected outlet temperature despite varying flow rates and inlet temperatures. As the flow rate increases (e.g. more taps are turned on), the water becomes cooler, so the firing rate increases.☼

Heating System Efficiency: Points to Consider

Equipment is tested and rated. That is what we show in the tables and what is listed in product literature. However, equipment efficiency is only one part of an efficient and effective heating system. The whole system design and installation needs to be considered. A properly designed system will provide a well-balanced source of heat distributed through the house. The most energy efficient equipment will not perform to expectations if it is poorly installed.

Ensure that system installed follows a designed layout in accordance with good engineering practice. Nationally HRAI (Heating, Refrigeration and Air Conditioning Institute of Canada) and in BC TECA (Thermal Environmental Comfort Association) provide training for mechanical trades and have design tools for the mechanical contractors, so there should be no excuse for installers not to do proper design.

Back of the envelope or rule of thumb system design should be a warning sign of possible trouble. The system designer should be able to provide a copy of the design calculations and a system layout design.

Points To Look For In Forced Warm Air Systems

Proper Design: ensure that a proper design heat loss calculation has been done. This will require a room-by-room heat loss calculation to allow a proper ducting layout to be done. If filters and central air conditioning are part of the system, they need to be part of the design as they impose resistance on the ducts and can affect actual delivered airflow.

Duct layout: ducts should be carefully designed and properly sized. This may require a variety of duct sizes based on airflow requirements and duct length. This is not a case where "one size fits all" is good enough.

Duct Sealing: sheet metal ducts are extremely leaky. In order to properly direct warm air where it is needed, the entire duct system should be sealed. This means all duct seams and joints should have either a foil duct tape or mastic sealer applied.

Grille Placement: grilles should be sized and placed to allow adequate airflow where it is needed. Decorative grilles could block a lot of airflow, so the system needs to compensate for the restrictions.

Controls: controls should be placed in appropriate locations (i.e. a thermostat placed in the sunny south side room, or immediately over or under a lamp or TV will be problem).

Commissioning: the entire system, not just the separate components, should be commissioned on completion to ensure that it works as intended.

Noise and Drafts: if these are observed, there probably is a problem with the system design or installation. A properly designed and installed system will be quiet and draft-free.

Points To Look For In Hydronic Systems

Design: ensure that a proper design heat loss calculation has been done. This will require a room-by-room heat loss calculation to allow a proper piping layout to be done. The CSA-B214 Installation Code for Hydronic Heating Systems provides guidance.

Controls: controls should be placed in appropriate locations. Where zoning is used, it should use appropriate layout. For example, south side rooms should be on a separate zone from north side. If it is an in-floor radiant system, controls should include an indoor and outdoor component.

Balancing dampers: these need to be installed and labeled to allow proper system balancing.

Commissioning: the entire system should be commissioned on completion to ensure that it works as intended.

Manifold Placement: manifolds are concentrations of heat, so placement against exterior walls should be avoided.☼

Spray Foam Insulation

Spray polyurethane foam (SPF) is increasingly being used as both insulation and an air barrier in residential construction. Because the materials are spray-applied, fully adhered and seamless, they eliminate connective gaps behind or through the insulation thus reducing air leakage and associated moisture movement.

Spray-applied polyurethane foam is a two-component product that is produced by a chemical reaction when two liquid components are combined – an isocyanate, known as the "A" component, and a polyol resin, known as the "B" component. These components include compounds that are catalysts, surfactants, fire retardants and blowing agents that define the properties of the end product. When the two liquids are mixed together a chemical reaction occurs instantly expanding it 20 to 150 times its liquid state, depending on the type of foam, and creating a rigid or semi-rigid foam. Once cured, which happens within seconds, the product hardens. R-values range from 3.6 to 6.5 per inch thickness, depending on the type of foam. The nature of polyurethane is to adhere tenaciously to most materials.

Currently, three types of spray foam are commonly used within the construction industry:

- a medium-density foam (2 pounds per cubic foot)
- a low-density foam (½ pound per cubic foot), and
- sealant foams.

The most important difference between the products is whether the formulation creates an open- or closed-cell foam. Both of these are used as an insulation and air barrier. Users need to understand the difference between the two types of foam. The low-density spray foam is generally referred to as ½-lb foam. When it is spray-applied to a substrate, it expands to about 150 times its original volume to form a semi-rigid, non-structural plastic that weighs between 0.4 and 0.6 lb/ft3 when cured, and it is typically sprayed in one pass. In wood frame walls, when sprayed between studs, it is sprayed to slightly overfill the wall cavity and then is trimmed flush to the stud face. Half-pound SPF typically has an R-value of about 3.6 to 3.8 per inch. Common trade names include ***Icynene*** and ***Enertite***.

The ½-lb foam is an open-cell material that will allow liquid water to pass through the foam. It is also very vapour permeable – 890-940 ng/Pa□s□m². (The Building Code defines a vapour barrier as having a permeance of 60 ng/Pa□s□m² or less). Thus, open-cell foams still require a vapour barrier. Typically, this may be a low permeance (vapour barrier) paint applied on the drywall. Sometimes, the vapour barrier paint is sprayed directly on the foam.

The 2-lb SPF has a lower expansion ratio than the ½-lb foam – expanding about 30-50 times its original volume. It weighs about 2 lb/ft³ when fully cured, and forms a rigid plastic with a higher compressive strength. If you cut a piece of 2-lb foam you would notice that it resembles extruded polystyrene foam and has similar properties. It has an aged R-value of about 6 to 6.5 per inch thickness. Some manufacturers claim that the long-term thermal resistance (R-value) of cellular plastics increases with thickness, and that is recognized in the latest ULC of CAN/ULC S705.1, the material standard that applies to spray foam insulation. However, in order to make the claim valid, the manufacturer is required to test their product in accordance with the standard.

Because the chemical reaction for the higher density 2-lb SPF generates high heat, it must be applied in multiple lifts to achieve the thickness required for the desired R-value. Typically this is no more than about 2 inches per pass, allowing a period of time for setting and cooling of the product.

Two-pound foam is a closed-cell foam that resists water absorption. It has a low vapour permeance (less than 60 ng/Pa□s□m² at 3 inches thick), so it can be used without a separate vapour retarder.

The sealant foams are typically packaged in small hand-held cans, and used to air seal minor gaps. These are used for air sealing, so their insulation values are not the significant feature. Rather, it is important to check whether it is a high or low expansion formulation. High expansion foams are not desirable for use around

windows and doors because they can impose significant pressure on the frames – enough to deform the frames.

Air Sealing Characteristics

Air barriers are important for controlling moisture/heat transfer. Field experience has shown that properly installed SPF, whether closed- or open-cell formulations, can significantly improve the air tightness of buildings since SPF is applied as a liquid and expands in all directions, filling and sealing all cracks in walls, ceilings, corners, joints and penetrations that would otherwise allow air ingress. Some products have been explicitly tested for their air barrier properties, and are being used as such to meet code air tightness requirements.

Because they form a good air barrier, both ½-lb and 2-lb SPFs can also help reduce noise from outside the building envelope, creating a quieter indoor environment. The ½-lb foam's density and flexibility offers additional sound absorbing qualities, and is occasionally used in interior partitions to reduce airborne noise transmission, although it is not exceptionally effective at reducing vibrational impact noises

Thermal barriers

All SPF insulation must have a thermal barrier covering to protect the insulation. The only place where it does not need a thermal barrier is in an attic space or crawlspace that is generally inaccessible or unused. Acceptable thermal protection is provided by gypsum board, plywood, OSB or particleboard.

Roof Ventilation

Both types of SPF can work well, and are being used in attics and cathedral ceilings without the need to ventilate. In other words, the SPF is applied directly to the underside of the roof sheathing.

Safety and health issues

Application of spray foam insulation is not a do-it-yourself job, as it requires specialized equipment and qualified installers. These are trained and licensed by either CUFCA (Canadian Urethane Foam Contractors Association) or by the manufacturer. SPF installation requires the use of appropriate personal protective equipment by the installer to avoid breathing fumes and keeping liquid components away from the skin or eyes. Care should also be taken to minimize exposure risk to building occupants during spray operations.

Cured SPF is relatively inert and has not been cited as a problem to allergy sufferers or to those with chemical sensitivities. ☼

Full depth insulation in ceiling rafters. ½-lb spray foam insulation after trimming.

2-lb foam in roof deck also provides insulation and air sealing at rim joists.

Spray Foam Insulation Must Be Installed Properly

The BC Safety Authority recently issued an information bulletin about the application of polyurethane spray foam insulation that has created some confusion and consternation among the industry and building officials. The bulletin essentially underlines the importance of strict adherence to the manufacturer's application instructions when spray foam insulation is applied in contact with electrical non-metallic sheathed cables.

The bulletin addresses a condition that could happen when 2-lb foam is improperly applied, especially during cold temperatures and on cold substrate materials. A condition known as 'reversion' could occur, which results in a hard lacquer-like coating created by the uncured chemicals. A lacquer-like coating that is created may bond to the nonmetallic cable sheath resulting in damage to the cable sheath when mechanical strain is applied to the cable. This happens at extremely cold temperatures, as could happen in many parts of Canada during a cold winter day when the temperature is sub-zero, when surfaces are cold, and if the foaming equipment and spray hoses are not at the proper temperature.

Uneven colour is an indicator of improperly applied and cured foam.

It has been observed that where an incomplete reaction occurs, the lacquer-like coating bonds tightly to the non-metallic cable sheath. When mechanical strain is applied to this section of cable later, the lacquer-like coating may break and crack or pull apart the cable sheathing. This damage happens only when stress is applied to the cables, such as when the wiring that has been embedded in the SPF is tugged at to make wiring changes. This condition occurs only with 2-lb foam.

It is strongly recommended to avoid moving, relocating or re-use of cables after they have been embedded in 2-lb polyurethane spray foam insulation. This only applies to the closed cell 2-lb foams.

BCSA Information Bulletin No: B-E3 070327 1: Application Of Polyurethane Spray Foam Insulation On Non-Metallic-Sheathed Cables

Letter to the Editor

Re: Energy Efficiency Upgrade Incentives
Solplan Review No. 135 (July 2007)

As always, I thoroughly enjoy every issue of your wonderful journal.

The July issue was very informative in the area of HRVs and reflective insulation. We have very active P2000 distributors and retailers in our area that make interesting work for us! Thanks for the concise recommendations, and the research you have shared with us.

Further to your items on energy efficiency upgrades in Ontario and the federal ecoEnergy incentives, you and your readers should be aware that Nova Scotia is a strong supporter of the EnerGuide for Houses program. We subsidize each audit to the amount of $300+, and we offer a range of matching provincial grants. Complete details are on our website:

http://www.conservens.ca/energuide

We also have an EnerGuide for New Houses program for new energy efficient homes. Information at: www.conservens.ca/energuidefornewhouses

Keep up the great work!

Hal Dobbelsteyn
Conserve Nova Scotia, Halifax, NS

Indoor Air Quality

People need air to survive. We know we need air to breathe, but we are not aware that on average a person consumes about 54 pounds of air per day. The indoor air we breathe can influence our physical health, and there are many contaminants we introduce indoors.

It is well understood that tobacco smoke contains thousands of chemical compounds that are liberated in the form of gases or particles, and more than 50 of the compounds are carcinogens.

Irritants in indoor air also originate from moisture and mould damage, building materials and furnishings and from the outdoors. How effective ventilation is and the way the building is used (occupancy level, pets, chemicals, etc.) will also affect air quality, and must be monitored. If humidity indoors is high or if the building has moisture or mould damage, a higher quantity of irritants may be emitted. High humidity also increases the risk that children will develop allergies to house dust and furry pets.

Swedish studies have shown that one child in five grows up in a home with signs of moisture or mould damage which today is the highest risk factor in the indoor environment.

Except in exceptional circumstances, outdoor air is better than indoors, since concentrations of contaminants will be lower. With effective ventilation, indoor humidity can be reduced, airborne contaminants removed and fresh air admitted. That is why it is essential that ventilation be adjusted according to the number of people and the way the premises are used.

Chemical emissions from building materials used in floors, walls and ceilings and furnishings can also contribute to higher concentrations of volatile organic compounds indoors. Some of these compounds affect health, but so far no individual compound has been associated with health effects at the concentrations typically measured in indoor air, although the synergistic effect of mixtures of compounds is not understood.

Additives such as fillers, plasticizers and stabilizers in plastics are used in large quantities and are now found almost everywhere. Products based on polymerized materials are used very extensively in dwellings, offices, schools and day nurseries. Research has found a relationship between moisture damage in buildings, the presence of polymeric materials and plasticizers in the indoor environment and children's health.

The one exception is formaldehyde which is a naturally occurring material. It is also used as the basic building block for many other products such as adhesives, fillers, sealants and cleaners and in chipboard and textiles. Formaldehyde chiefly causes irritation in the eyes and upper airways of adults. Formaldehyde concentrations in homes generally are low, below the level where irritation has been noted. However, homes with poor ventilation and high quantities of synthetic materials including pressboard could have high levels.

Renovation, painting and new furniture always mean that the concentration of chemical compounds in the indoor air will be temporarily higher. Many emissions dissipate over time, but it is wise, as an extra precaution, that when painting is done in occupied homes (even with low emission paints), the home be flushed out (well ventilated at peak capacity) for several days. It is also advisable that painting not be done in rooms where very small children will be present for extended periods.

Particulates

Small particles can remain airborne for a long time and can therefore be inhaled.

Health effects associated with PM2.5 (particles smaller than 2.5 μm) in indoor air in homes have been described in a number of epidemiological studies. These suggest that high concentrations of the small particles in the home environment can lead to changes in lung function, inflammation of the bronchi, bronchial complaints, asthma and chronic bronchitis.

More than half of small particles in indoor air come from the outdoors through ventilation and open windows. While incoming ventilation air – in a central ventilation system – could be filtered, that coming through open windows and doors or uncontrolled air leakage will not be.

Dust in the environment is a source of allergic complaints, hay fever and asthma incidents. In office environments, cleaning and air purification have been shown to reduce complaints, but it is probable that many other factors also interact.

Combustion gases from gas cooktops may, for short periods, give rise to high concentrations of nitrous oxides. These have been shown to pose an increased risk of airways symptoms, mostly in people who are already sensitive.☼

Energy Standards for Houses

The concern about climate change means that all sectors of society will have to change the way things are done. For the building sector, this means more stringent energy efficiency standards. The EnerGuide for New Houses (EGNH) rating has been proposed in a number of jurisdictions in Canada as a regulatory means to evaluate the energy efficiency of new homes built under Part 9 of the Building Code, and setting a mandatory performance benchmark of EnerGuide 80.

Concerns about the use of the EnerGuide rating have been raised. Widespread reliance on EnerGuide will require ensuring that there are adequate numbers of energy evaluators in place. As demand for services becomes evident, it will be easier to recruit evaluators.

However, the more fundamental issue is where or how the energy target for new construction is set. Although we all want to have a say in the matter, at the end of the day it will be those with regulatory responsibility that will call the shots. From the point of view of energy use reductions, absolute energy reduction targets must be set and they need to be substantive. Decisions need to be taken in the public interest based on other than purely economic basis.

Energy pricing policy is fraught with artificial, politically based decisions. Making public policy decisions strictly on energy pricing today is dangerous – since energy costs are so volatile. In Canada, energy has been under priced in the past. The trend worldwide is moving to a carbon based analysis, irrespective of current local pricing. This may not be popular with everyone, because it represents a significant change.

One argument made is that EGNH ratings do not represent actual energy performance. Unfortunately, this misses a key point – the ratings are not meant to represent "real" operating conditions, but rather to be tool to enable the comparison of houses on an equal basis, irrespective of lifestyle issues and year-to-year weather variability. The EGNH ratings are analogous to the energy performance ratings for all kinds of appliances – even the AFUE ratings for furnaces. None ever perform as tested, but they allow a basis of comparison and indicate general performance levels. No one really expects that the mileage ratings on an automobile are going to be the same as on the road performance, but they do provide a relative comparison between different models. The EGNH number is similar to that.

Another complaint is that EGNH ratings are calculated using software that is continually being revised – so the ratings are going to change all the time. However, what software is not updated? What standard is not updated? The building code itself is constantly updated. The EGNH rating is valid the date it is issued – what happens later is not an issue. In the same way, most existing houses today are no longer compliant with the building code because they were built under old editions of the building code (or even before there was a building code), which has been changed over the years.

EGNH is a standard that was developed by NRCan without the same sort of consultation that goes into code development, but they have in-house technical expertise and they use technical input from all sectors of the industry. HOT2000, the software used to generate the rating, has been verified internationally. Performance simulations with adjustments made to reconcile for actual lifestyle and climate conditions will generate results essentially matching actual conditions.

A strong point of the EnerGuide approach is that it is a *performance*, rather than prescriptive approach, allowing builders and designers to chose what works for them, the design and the local conditions. Builders chose the options they will use. Because the software involves a simulation, the results are climate sensitive.

The EGNH scale applies to both new and existing construction. New house homebuilders also compete with the existing housing stock. EGNH provides them a scale by which the higher standard of new construction can be judged and showcased. From a public policy point of view, it provides a means for judging new houses against older homes (the bulk of the building stock that will be with us for a long time) and a way for upgrading their existing housing stock when renovating. And to date, more than 300,000 houses in Canada, both new and old, have been evaluated using the EnerGuide rating.

The EGNH scale is from 0 to 100, with new homes falling within a small part of the scale. Instructing people about the meaning of a scale is always a challenge, but it doesn't matter how the scale is set, it will need some explanation.

Mandating energy performance level at EnergGuide 80 should not have a negative impact on innovation in building design and construction. A performance standard doesn't stifle innovation. Rather, it is prescriptive standards that are much more restrictive. Any prescriptive requirements for an equivalent to an EGNH 80 performance level, which will have to be developed for those unable or unwilling to do an evaluation, will be more onerous.

The EGNH ratings consider all factors in a house that affect energy consumption – building envelope as well as mechanical systems, orientation and default assumptions for lifestyle and interior loads. These latter are made using the best information available today – there still is little definitive data on interior loads, and in any case these are constantly changing and lifestyle dependent (i.e. loads due to home electronics, standby loads of appliances, etc), so it's not something that can be regulated by a building code.

EnerGuide rating is a rigorous, scientifically based assessment tool. Although one can always make improvements, it must be recognized that it has been reviewed and is internationally recognized as an assessment approach with substance.

The bottom line is how do we draft regulations to raise the minimum bar all houses must meet. The EGNH rating offers one approach that is performance based, allowing builders to decide how to meet the minimum standard. It won't stop builders from doing better. Houses built to EGNH 80 will be significantly more energy efficient than current code houses.☼

Environment and Global Warming are Top Issues for Canadians

Those that still are of the opinion that environmental and climate change concerns are nonsense (and that seems to be the opinion of many in the business community and government) should take note. Almost every Canadian now thinks that global warming is a serious issue today and supports immediate action. Support for action is driven by a sense that global warming is not a theory or a passing fad. More than 8 in 10 are convinced that global warming has been scientifically proven.

According to a survey by TNS Canadian Facts, a major research firm, there is a sense that governments at all levels are not doing enough to tackle global warming. Environment and global warming are identified as the most important issue affecting the world today. Seven in 10 Canadians think the federal and provincial governments are not doing enough. Municipalities are more likely to be viewed as doing the right amount (32%) but even at this level many Canadians (59%) would like to see more action through eco-friendly programs and policies.

The study shows that, in general, Canadians are most willing to do the relatively easy and cost-free activities to reduce their environmental footprint. The top three actions that they are most likely to take are recycling (91% definitely will), purchasing appliances that are energy efficient (66%) and replacing traditional light bulbs with environmentally friendly ones (63%). However, Canadians are not as willing to change their driving habits. This may be a reflection of the way our cities have been built up and that there are few alternatives at present to the automobile.

The study also found that there is a high level of interest in low-impact renewable, green power. Although availability varies across the country, in general Canadians are not aware of the main options when purchasing green power – bundled green power whether through certificates or from independent retailers. When it comes to their specific area, the study notes that few (9%) are aware of the ability to buy green power in their area and fewer still (3%) are currently purchasing green power.

Just over half (55%) of all Canadians say they probably (36%) or definitely (19%) would buy green power if there were a 10 per cent premium for getting half of their power from environmentally-friendly renewable sources. Atlantic and Quebec residents are the most likely to support the purchase of green power.☼

Technical Research Committee News

Field Investigation On The Use Of ACQ Treated Wood And Metal Fasteners And Connectors

Since 2004, use of chromated copper arsenate (CCA) treated lumber has been phased out in residential use (although CCA-treated plywood and shingles or shakes are still permitted).

Treated wood in residential buildings is being replaced with Alkaline Copper Quaternary (ACQ) or Copper Azole (CA-B) treated lumber. The copper contents in these new preservatives are significantly greater, which increases the risk of galvanic corrosion.

Because of many problems that have been reported by builders and warranty insurance companies, the Homeowner Protection Office (HPO) in BC commissioned a limited survey at locations in the Lower Mainland and on Vancouver Island to assess the problems of corrosion from metal fasteners and connectors in contact with ACQ treated wood.

The study found that even though the connectors which had been specified and used, met the G185 galvanized level, red rust was visible on some connectors. Some corrosion is likely occurring due to residual water and mobile copper in the treated wood at time of construction. In other examples, the corrosion was observed only on samples exposed to weather, indicating that in these cases the combination of rainfall and residual mobile copper in the wood had produced the corrosion.

In some buildings, the corrosion was much more evident on lumber that had been incised to improve the level of preservative penetration. Consequently, the corrosion hazard was greater because of the larger preservative loading found at the surface of incised treated lumber. It was also noted that in many cases fasteners that were not galvanized had been used.

Based on the preliminary survey, a more comprehensive study is underway, which will include removal of fasteners to more accurately identify the degree of corrosion taking place.

Field Investigations On The Application Of ACQ Treated Wood And Use Of Metal Fasteners And Connectors In Residential Construction Prepared for Homeowner Protection Office by Dr. John N.R. Ruddick

Materials that have been suggested by manufacturers as being compatible with ACQ and CA-B pressure-treated wood	
Fasteners	Stainless steel, hot-dipped galvanized (G185) and polymer coated.
Connectors	Stainless steel and hot-dipped galvanized. Hot-dipped galvanized connectors must have a minimum coating of G185 (more than triple the G60 coating required for CCA treated lumber).
Flashings	Stainless steel, copper and flexible membranes.
Foundation sill plates	Hot-dipped galvanized (G185) anchor bolts and strap anchors

Canadian Home Builders' Association

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.

Canadian Home Builders' Association, Suite 500, 150 Laurier Ave. West, Ottawa, Ont. K1P 5J4
Tel: (613) 230-3060
Fax: (613) 232-8214
e-mail: chba@chba.ca
www.chba.ca

Energy Answers

Rob Dumont

How much insulation should you put on a storage tank for hot water?

The answer to this question is not as simple as one would first expect.

I do know that standard hot water tanks lose a lot of energy. For instance, the 40 US gallon (151 litre) electric water heater in our house came with about 1-inch (25 mm) of glass fibre insulation. I put a kilowatt-hour meter on the unit and measured a continuous standby heat loss of about 100 watts for the unit. Over the period of a year, this would amount to 876 kilowatt hours or 3.2 Gigajoules (3.4 million BTU). For comparison, the average heating load (excluding losses) for hot water in a house is about 3900 kilowatt-hours per year. In other words, the jacket losses amount to about 22% of the useful output of a typical water heater. Ouch.

I retrofitted the water heater by adding about R28 insulation to the tank and by adding foam insulation on the inlet and outlet piping. With this upgrade, the standby heat loss dropped from 100 watts to 25 watts, or 5.5% of the useful output of a typical water heater.

A complicating factor with heat storage tanks is that the heat that is lost may be of use to the house during the heating season. However, the heat that is lost also adds to the cooling load in the house during the cooling season.

If you go to the ASHRAE Handbooks, a detailed methodology for calculating the optimum thickness of insulation is presented. Here's a quote from the 1997 Handbook of Fundamentals: "Determining the most profitable thickness of insulation is difficult. The economics of each plant (including cost of producing energy, cost of insulating, discount rate or cost of capital, and potential for energy loss) indicate the preferred amount of insulation… This analysis is further complicated because future energy cost and the life of the facility and insulation must also be considered."

Given all the complexity in the equations, it is, as stated in the Handbook, a "difficult" issue to calculate the appropriate amount of insulation to be used.

Here is a quote from Aristotle, writing some 2300 years ago, that is of use to the analysis: "It is the mark of an instructed mind to rest assured with that degree of precision that the nature of the subject admits, and not to seek exactness when only an approximation of the truth is possible."

Inspired by Aristotle, my line of reasoning on the issue of how much insulation to use is as follows:

1. Heat loss from a storage tank is undesirable for a good part of the year.
2. Insulation is a relatively inexpensive way to control the heat loss.
3. There are no moving parts or maintenance issues with properly installed insulation.
4. The annual heating degree days for a water storage tank at 55°C in a room at 18°C amount to 13,505 heating degree-days (base 18°C).
5. For comparison, the annual heating degree-days for outside temperature conditions (base 18°C) are as follows in Canada:

Vancouver	3000 DD°C
Toronto	3650 DD°C
Saskatoon	5950 DD°C
Yellowknife	8500 DD°C
Eureka, NWT	13,800 DD°C

In other words, the heat storage tank experiences heating degree-day values that are greater than virtually all locations in Canada.

6. Most attics in new houses these days use insulation levels in the R40 (RSI 7.0) range. Most walls have insulation levels that are nominally R20 or effectively about R16 or 17 when thermal bridges are taken into account.
7. Most new houses have better insulation, air tightness, windows, etc., and the effective heating season is effectively shorter than it used to be. A well-built new house in most parts of southern Canada would only have a heating season of about half a year.
8. Most fuel-fired tank type water heaters are inefficient compared with newer furnaces.

Based on the above general principles, I would estimate that a typical water heater in a house should have an insulation value in the range of R-30 to R-40. None of the commercially available tanks, to my knowledge, offer such an insulation level even as an option.

In the September 2001 issue of Solplan Review, I presented a technique for adding lots of insulation to a hot water tank. Basically it consists of adding vertical glass fibre batts to the outside of the tank and covering the batts with foil-backed insulation. If you are using a fuel-fired tank, be very careful not to obstruct the air supply for combustion and for dilution at the top of the water heater. In addition, be very careful to attach the insulation so that it does not move and obstruct the air supplies.

In summary, existing hot water storage tanks are very deficient in the amount of insulation used. Going to R-30, R-40, or even higher amounts of insulation on the tanks is an excellent idea.☼

Solar Energy Applications

To be efficient solar applications must match the energy need and form of the end use: thermal heat when that is needed (for space or domestic hot water heating) and electricity for electrical applications.

If you need warm water, a solar water heater can provide that, or at least a portion of it. It is pointless (and expensive) to use solar energy to generate electricity only to heat some water - yet that is what we do with our grid-connected houses when we use electric water heaters. Increasingly solar energy is being used to heat domestic hot water for showers and swimming pools.

We're familiar with solar cells to generate electricity for calculators, garden lights, streetlights, traffic signals, and many other applications.

Today, solar electric cells and solar thermal panels are gaining ground all over the world. In some parts of the world, solar water heaters are the only type allowable. Solar heat is being installed on a large scale in China, and German farmers are mounting solar cells on the roofs of their farm buildings and selling excess electricity to the grid.

Even at northern latitudes, with the short winter days and cold climates, solar water heaters can provide a reasonable amount of space heating and hot water, as many cottagers have discovered.

It is perhaps the development of solar (electric) cells that is experiencing the most dramatic evolution. We are seeing many building integrated applications of photovoltaic cells. All of the Equilibrium designs presently under construction include some PV panels.

Worldwide in 2005, PV cells with a total output of 1400 MW were installed – much of it grid connected. However, solar cells are expensive; (one square meter of solar cells costs about $800) and they convert only 12% of the sunlight into electricity. The remaining 88% is lost as heat. Focusing the light with mirrors or lenses can reduce the number of solar cells per square meter. In climates with the right conditions, this may provide a more economical power source. Several large focusing solar heating and power systems have been built in Australia and on the Canary Islands to demonstrate that this is feasible.

At Lund University in Sweden work is underway on a number of concentrating systems. A Swedish company is looking at commercializing such hybrid systems because they see the potential for a new type of solar collector that could generate both electricity and heat. Because it is not possible to test during the winter months because of the northern latitude, the Swedish testing Research Institute is pursing test sites in other countries.☼

energy efficient, sustainable, and healthy buildings
design & consulting services
R-2000 File Management
HOT-2000 Analysis
SuperE™ House Program
Design Professional

Richard Kadulski Architect

#204 - 1037 West Broadway
Vancouver, B.C. V6H 1E3
Tel: (604) 689-1841
Fax: (604) 689-1841
e-mail: kadulski@direct.ca

NRC·CNRC

IRC Software for Building Designers

By John Burrows

One of the outcomes of research at the NRC Institute for Research in Construction (NRC-IRC) is software that can help building professionals design better buildings and help material manufacturers design better products. This article outlines several software programs concerned with the indoor environment that were recently developed by NRC-IRC. Most are available free of charge.

Lighting Design

DAYSIM is a daylighting design tool used to predict the annual amount of daylight in buildings with an arbitrary, complex shape located anywhere in the world. It calculates the daylight factor (the relative amount of daylight inside a building compared to the daylight outside on a cloudy, overcast day) as well as the percentage of the occupied hours of the year when there is enough daylight inside the building to work without the need for electric lighting. It predicts the lighting energy use of commercial buildings for a variety of lighting control systems including occupancy sensors, photocell-controlled dimming, and standard on/off switches.

DAYSIM has been designed to link to the ECOTECT building design software, allowing users to quickly set up a building model in ECOTECT, import it into DAYSIM for a daylighting analysis, and export it back into ECOTECT for a state-of-the-art graphical presentation.

SkyVision enables users to predict skylight performance for any given day, using different design variables under virtually any condition. It calculates the overall optical characteristics of various types of skylights, performance indicators of skylight/room interfaces, indoor daylight availability, and lighting energy savings (daily, monthly, and annually). This tool is useful for assessing the costs and benefits of including skylights in a building.

Daylight 1-2-3 is a sophisticated but easy-to-use daylighting design analysis tool that allows designers to take advantage of the fact that daylight is more desired by occupants than electrical illumination, and that its use can also lead to substantial energy savings. It is intended for use by anyone making daylighting-related design decisions in commercial buildings at the initial development stage. It combines the capabilities of DAYSIM, SkyVision and the ESP-r thermal simulation engine, enabling it to optimize the amount of natural light in a space together with its annual energy use. Simulations provide calculations based on climate information in virtually every country around the world.

Daylight 1-2-3 predicts the daylighting and energy performance of side-lit and top-lit private offices, open-plan offices, and classrooms. Factors taken into account include:

- glazing type;
- window blinds;
- the electric lighting control system (manual, dimming, occupancy sensor);
- skylights.

Indoor Air Quality

IA-QUEST is an indoor air quality emission simulation tool that was an end product of an NRC-IRC consortium project established to develop guidelines for selecting materials and ventilation strategies to meet specific indoor air quality requirements. The software consists of two parts: a database and the simulation tool. The database stores test emission data ("off-gassing") for 90 "target" volatile organic compounds (VOCs), "abundant" VOCs and TVOCs (total VOCs) for 69 building materials commonly used in Canada. It also provides information about specimen details and test conditions involved in measuring the emissions. The simulation part predicts the indoor air contaminant concentrations in a room for which specific materials (from the database) and ventilation conditions/strategies are selected.

Insulating Buildings from Aircraft Noise

The **IBANA-Calc** software calculates indoor sound levels from aircraft noise for both residential and commercial building envelope designs. It enables users to view comparisons of designs, refer to printed reports and listen to simulated aircraft noise as it would be heard indoors. It is intended to resolve the difficulty of relating decibel ratings to what one actually hears—a frequent challenge for architects and interior designers. It allows designers to compare various designs.

John Burrows is an Ottawa-based consultant and technical writer.

Summary

These software packages reflect the fact that design tools are an important element of the NRC-IRC strategy for transferring knowledge to the construction industry. Several of the tools described here continue to be enhanced as new information becomes available. Further details about these software packages and purchase/download instructions can be found at:

http://irc.nrc-cnrc.gc.ca/software_e.html

This Web site link also provides access to NRC-IRC software on subjects other than the indoor environment, such as fire safety, heat, air and moisture transfer in walls, and infrastructure.

Solplan Review Back issues

A limited number of back issues are available, at a special price of $5.75 each (plus 6% GST).

Bundle special: a random selection of back issues (minimum 22 copies) are available for only $65.00 (plus 6% GST)

Solplan Review
Box 86627
North Vancouver, BC V7L 4L2
e-mail: solplan@shaw.ca

Fire Research for Better Building Design: NRC-IRC

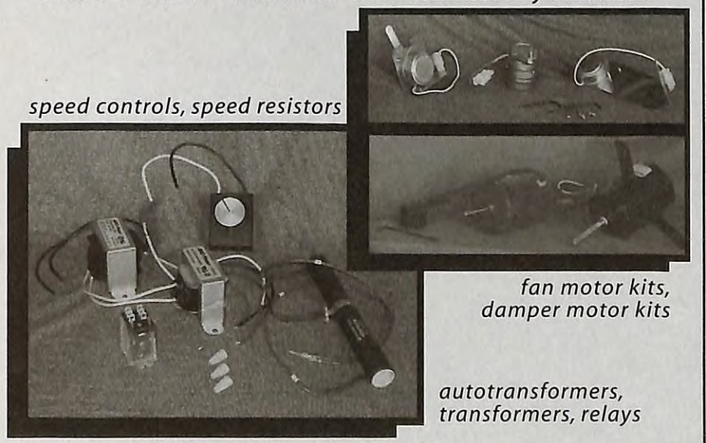
Construction practitioners will hear the latest research advances in design for fire, smoke control, fire-suppression and occupant evacuation when the National Research Council launches its annual Building Science Insight seminar tour in October 2007. Scientists from the NRC Institute for Research in Construction (NRC-IRC) will present their findings and discuss design implications in daylong sessions slated for 15 major cities across Canada.

The fire seminar series draws on the results of NRC-IRC's extensive research collaborations with industry partners including major associations, government agencies and private companies in Canada and the United States.

The research team will also present two case studies: one on the use of photoluminescent material for emergency evacuation, and the other on the use of a sprinkler system for the fire protection of windows.

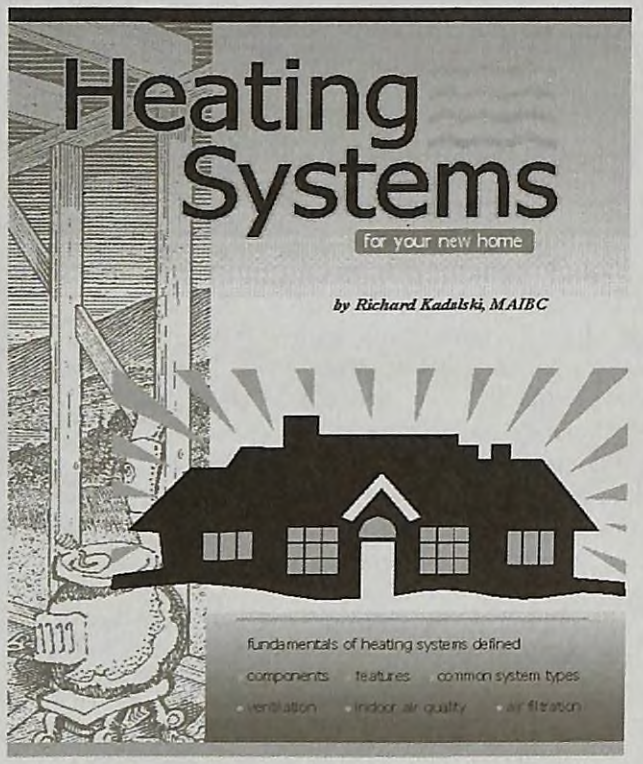
For details and registration information: *http://bsi.gc.ca*

Electrical Replacement Parts *for Saskatoon-built vanEE®, ENEREADY vanEE® and ENEREADY™ Heat Recovery Ventilators*



ENEREADY PRODUCTS LTD.

#4 - 6420 Beresford Street • Burnaby • British Columbia CANADA • V5E 1B6
Telephone: 604-433-5697 • Fax: 604-438-8906 • www.enereadyproducts.com



$19.95 Mail order: $ 23.79 ($19.95 + plus $ 2.50 shipping & handling + GST)

Available Now!

Heating Systems
for your new home
by Richard Kadulski, MAIBC

Heating Systems for Your New Home is the book that explains heating system options for your new home.

Contents include:

- **Heating Fundamentals**
- **Heating System Types**
- **Features to consider**
- **Common system types described**
- **Overview of ventilation**
- **Filtration**
- And much more!

the drawing-room graphic services ltd.
Box 86627 North Vancouver, B.C. V7L 4L2
FAX (604) 689-1841
e-mail: solplan@shaw.ca

SOLPLAN REVIEW is an independent Canadian Journal published 6 times per year to serve the needs of professionals and interested lay persons. It provides news, technical details, new product information, insights and commentary on developments covering all aspects of building science and energy efficient building practice for new and retrofit residential construction. Technical information is presented in a clear, concise manner without resorting to jargon.

SOLPLAN REVIEW is an independent subscription supported publication that relies on the support of readers. If you are seeing this journal for the first time, and find it valuable, why not ensure that you don't miss any copies. Subscribe today!

YES, I WANT TO SUBSCRIBE TO SOLPLAN REVIEW

In Canada: 1 year: $51.94 ($49.00 + 2.94) [NB, NS, NL $55.86 includes HST]
2 years: $93.28 ($88.00 + 5.28) [NB, NS, NL $100.32 includes HST]
USA and other foreign: 1 year $56.00 per year, 2 years $102.00 (USA and other foreign in US funds).
Pay by: VISA ☐ MASTERCARD ☐ AMERICAN EXPRESS ☐ CHEQUE/CHECK ☐

Card No _____ Exp date _____

Signature _____

NAME _____

ADDRESS _____

_____

POST CODE _____

the drawing-room graphis services ltd.
PO Box 86627 North Vancouver, BC V7L 4L2
Fax: 604-689-1841
e-mail: solplan@shaw.ca

GST registration: R105208805